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Applied anatomy of the lingual nerve: Relevance to dental anaesthesia

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ABSTRACT

Objectives: (1) to classify the external morphology of the lingual nerve and investigate any relationship between its external and internal morphology, (2) to explore the fascicular structure, nerve tissue density and capillary density of the lingual nerve, and (3) to provide an anatomical explanation as to why adverse clinical outcomes more commonly affect the lingual nerve following local dental anaesthesia. Where possible, comparisons were made between the lingual and inferior alveolar nerves.
Materials and methods: The lingual and inferior alveolar nerves were examined in 23 hemisectioned heads macroscopically and microscopically 2 mm above the lingula. The lingual nerve was also examined in the regions of the third and second molars. Specimens underwent histological processing and staining with Haematoxylin & Eosin, Masson's Trichrome, anti-GLUT-1 and anti-CD 34.
Results: The lingual nerve became flatter as it traversed through the pterygomandibular space. There was an increase in the connective tissue and a decrease in nerve tissue density along the lingual nerve ($p < 0.001$). At 2 mm above the lingula, the lingual nerve was unifascicular in 39% of cases, whilst the inferior alveolar nerve consistently had more fascicles ($p < 0.001$). The lingual nerve fascicles had thicker perineurium but the endoneurial vascular density was not significantly different in the two nerves.
Conclusions: The greater susceptibility of lingual nerve dysfunction during inferior alveolar nerve blocks may be due to its uni-fascicular structure and the thicker perineurium, leading to increased endoneurial pressure and involvement of all axons if oedema or haemorrhage occurs due to trauma.

1. Introduction

Originating from the mandibular division of the trigeminal nerve (cranial nerve V) within the infratemporal fossa, the lingual nerve travels in an anterior direction towards the medial surface of the mandible. As it reaches the lingual plate in the vicinity of the mandibular third molar, it is covered only by the gingival mucoperiosteum.[1] The lingual nerve continues to travel anteriorly, crossing the lateral and inferior surfaces of the submandibular duct, before passing upwards to reach the ventral surface of the tongue where it divides into its terminal branches.[2–5] The main functions of the lingual nerve are to provide general sensation to the mucosa and papillae of the anterior two thirds of the tongue, mandibular gingivae

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(lingual) and mucosa of the floor of the mouth. As it incorporates the chorda tympani nerve, it also carries taste sensation from the taste buds of the anterior two thirds of the tongue, and delivers parasympathetic secretomotor innervations to the submandibular and sublingual salivary glands.[3–6] Whilst the lingual nerve tends to follow a defined path, its disposition towards anatomical variations adds a dimension of complexity which increases the risk of damage.

The lingual nerve may be susceptible to physical and chemical damage during dental procedures, which may manifest as a temporary or permanent sensory disturbance. In order of frequency, the most commonly-reported dental causes of lingual and inferior alveolar nerve damage are mandibular third molar surgery, followed by inferior alveolar nerve blocks, and then endodontic and periodontal complications.[7–12] For reasons unknown, dysaesthesia occurs at a higher frequency after injuries associated with inferior alveolar nerve blocks (34%) than after mandibular third molar surgery (8%).[13] It has also been consistently reported that the lingual nerve suffers a greater frequency of permanent neural damage than the inferior alveolar nerve, particularly during inferior alveolar nerve blocks.[14] The incidence of nerve damage as a result of inferior alveolar nerve blocks has been estimated to be in the range of 1:26,000 to 1:800,000, with the lingual nerve reported to sustain damage more frequently (~70%), compared with the inferior alveolar nerve (~30%).[13,15,16] In a study by Garisto et al.[17], the lingual nerve was affected in as many as 89% of cases involving nerve paraesthesia after inferior alveolar nerve blocks.

Several hypotheses have been put forward to explain this phenomenon, including the tendency for the lingual nerve to be uni-fascicular at the level where inferior alveolar nerve blocks are administered.[14] Other factors to consider may be the different locations of the nerves, with the lingual nerve being only 5–6 mm below the surface mucosa, or because of the lack of bony protection to the lingual nerve by the features on the medial aspect of the mandibular ramus, such as the lingula and the crista endocoronoidea.[18,19] In addition, it has also been suggested that the lingual nerve has a tendency to be stretched taut during the administration of inferior alveolar nerve blocks, as the lingual nerve may be bound down by the interpterygoid fascia during the opening of the mandible, and consequently unable to move when it comes into contact with an injecting needle.[20] This will consequentially result in needle penetration of the nerve, resulting in damage to nerve fibres.

The consequences of neural damage following a traumatic incident may manifest as numerous subjective symptoms, ranging from sensory deficit such as anaesthesia (complete loss of feeling) or hypoaesthesia (diminished sensitivity to all forms of stimulation), to abnormal neuro-sensory disturbances such as paraesthesia (numb feeling, burning and prickling sensation), dysaesthesia (painful sensation), hyperaesthesia (increased sensitivity), and allodynia, where there is pain from stimulus that is not normally painful when applied elsewhere to the body. When the lingual nerve is involved, the chorda tympani branch of the facial nerve may also be affected, leading to dysgeusia (impaired sense of taste) and xerostomia (reduced salivation).[9,12,21] Although extremely rare, altered sensation in the maxilla may also occur as a consequence.[22] Other problems associated with diminished function of the lingual and inferior alveolar nerves include difficulty with speech, gustatory impediment, hindrance to social interaction, problems with tooth brushing, mechanical (biting) and thermal trauma when there is paraesthesia of the tongue and lip, and sleep disturbances where allodynia is present.[21,23] Injury to the lingual nerve has also been associated with changes in the epithelium of the tongue, with a decrease in the number of fungiform papillae.[1,23] If there is localised fascicular damage, it is expected that only the skin, mucosal surfaces or sensory parameters supplied by that fascicle(s) are disrupted.[7]

Fortunately, most neural injuries caused by clinical procedures, such as mandibular third molar surgery and local anaesthetic injections, resolve without treatment within a few months.[12,23,24] Although neural damage is rare and the prognosis generally favourable, it should still be of concern as its consequences can be distressing to the affected patient. It is therefore paramount that situations in which dental procedures may cause unintentional impairment to the lingual and inferior alveolar nerves are well understood, so that appropriate prevention and management can be implemented efficiently. This study aims to improve our understanding of the clinical anatomy of the lingual and inferior alveolar nerves to diminish the chances of iatrogenic damage. More specifically, our aims are:

Aim 1: To investigate whether there is any relationship between the external and internal morphologies of the lingual nerve. We hypothesise that the lingual nerve becomes flatter as it descends through the pterygomandibular space towards the tongue.

Aim 2: To explore the fascicular structure and nerve tissue density of the lingual nerve as it descends through the pterygomandibular space and oral cavity and, where possible, to make comparisons with the inferior alveolar nerve. We hypothesise that there is an increase in fascicle number and nerve tissue density along the length of the lingual nerve. Furthermore, we hypothesise that the lingual nerve has fewer fascicles when compared with the inferior alveolar nerve at the level of the lingula, and a lower nerve tissue density.

Aim 3: To determine the capillary density in the lingual nerve compared with the inferior alveolar nerve. We hypothesise that the lingual nerve has a greater capillary density than the inferior alveolar nerve at the level of the lingula.

Aim 4: To provide an anatomical explanation about why adverse clinical outcomes affect the lingual nerve more frequently following local anaesthetic use in dentistry.

2. Materials and methods

This study used 23 hemi-sectioned heads from different cadavers, which had been preserved for 1–4 years, and ranged from 65 to 103 years of age at the time of donation. All donors had signed approval for the use of their mortal remains for research as part of the donor program, and approved by the Head of School. Of the 23 specimens, 14 were edentulous. Dissections were performed from the medial aspect to carefully expose the lingual and inferior alveolar nerves.